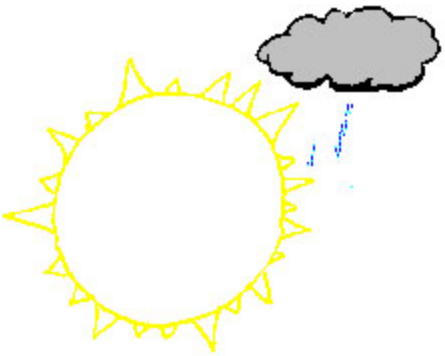
Weather

Weather Phenomena and Instruments



GRADE LEVELS

Grades 5 – 8

OBJECTIVES

While completing the following activities, students will:

- Explore different weather phenomena.
- Describe and measure wind.
- Investigate Sun-Earth connections.

KEY WORDS

air masses
climate zones
cloud
Coriolis effect
Earth's axis
equator
front
heat energy
hurricane
latitude
meteorology
meteorologists
precipitation
radiation
season
thunderstorm
tornado
weather
wind

BACKGROUND INFORMATION

Weather is the state of the atmosphere at any given time and place. Most weather takes place in the lower layer of the atmosphere. Weather occurs because our atmosphere is in constant motion. Some determining factors of weather are temperature, **precipitation**, **fronts**, **cloud** type, and **wind**. Other more severe weather conditions are **hurricane**s, **tornado**es, and **thunderstorm**s. When air is sinking, good clear weather occurs because the air is stable. However, cloudy and murky weather occurs when air rises because it is unstable. Weather changes occur throughout the day. Weather also changes every **season** because of the Earth's tilt when it revolves around the Sun.

Meteorology is the study of weather, and **meteorologists** are scientists who study and predict weather. Your local weather person is probably a meteorologist. They let you know what the weather might be so that you can plan your activities for the day.

TEACHER PREPARATION

Begin by asking questions to find out what students already know about weather. Example: How did you decide what to wear to school today? Some students may indicate that the temperature had an influence on what they wore. Pursue the idea that weather often determines what we wear and what we do. Ask why we wear different clothing in the winter. Students may respond that the weather changes. Ask them for their own definition of weather. Try to relate that weather is the condition of the air around us and that temperature is one of the factors that effect air, causing changes in weather. Continue to point out that the atmosphere is the air, like a blanket, around us.

ACTIVITY ONE
What makes the weather?

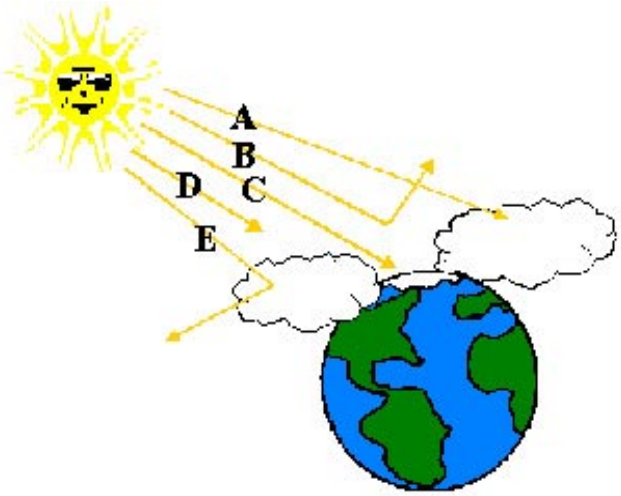
Sun/Earth Connections

This gives students the opportunity to investigate Sun-Earth connections and their effects on weather.

TEACHER PREPARATION

The Sun releases ultra violet radiation into space that reaches Earth. Several factors affect the amount of radiation that is absorbed by Earth at different places. Because Earth is a sphere, the sun's rays strike different places at different angles. Near the **equator** the Sun passes almost directly overhead. North and south of the equator, the surface of the sphere curves away from the Sun. As a result, these locations receive less solar energy. Other factors include the tilt of **Earth's axis**, its day and night periods, and its path around the Sun. Unequal absorption of **radiation** causes unequal heating of Earth's surface. Because the atmosphere is heated by Earth's surface, it too is heated unequally. Air near the equator is heated more than air near the poles. Heated air expands. Thus warm air at the equator is less dense than cold air at the poles. The density of the air determines the force with which it presses down on Earth's surface. This force is measured as air pressure. Cold air presses down on the earth with a greater pressure than warm air. Cold air is said to have a high pressure. Warm air is said to have a low pressure. Review with the students the concept of air pressure and its effects.

The sun's energy reaches Earth as sunlight. Energy waves are absorbed by the Earth and returned to the air as **heat energy**. However, only a part of the sun's radiant energy ever reaches the Earth. The diagram below shows factors that control how much energy Earth receives from the sun.



A - 8% of radiation absorbed by water vapor and clouds
B - 2% of radiation scattered by ozone
C - 30% – 60% of radiation reaches Earth depending on cloud cover
D - 10% of radiation absorbed or scattered by gas molecules
E - 20% – 50% reflected or scattered by clouds

Heating Earth

In this activity, students will investigate the heating of Earth by the Sun at different latitudes.

MATERIALS

- Flashlight
- Sheet of black paper
- Globe
- Three small thermometers
- 250 watt light bulb and lamp

QUESTIONS

- How does the way sunlight hits Earth change during the day?
- Describe what happens to the temperature at different times of the day. Why are there changes?
- What causes the air temperature to become warm?
- How do surfaces affect air temperatures?
- What other factors might affect the amount of radiation that is absorbed by the earth at different places?
- Which places in the world would have higher temperatures? Why?

PROCEDURE

Step 1
Lay the black paper flat on the top of a table. Shine the flashlight on the paper. Observe the size and brightness of the lighted area on the paper. Tape one end of the paper to the top of a table. Then while holding the sheet of paper straight up and down, shine the flashlight directly at the paper. Next, hold the flashlight in the same place, but slowly move the top of the paper away from the light without bending the paper. The light should hit the paper less directly. Observe the size and brightness of the lighted area. Discuss which angle of light made the biggest lighted area. If the light were sunlight, which direction would heat the paper the most?

Step 2
Using a large globe, tape one of three small thermometers at the equator, at 40 degrees **latitude**, and at the North or South Pole. Be sure the globe is tipped at the correct angle for the season you are currently in.

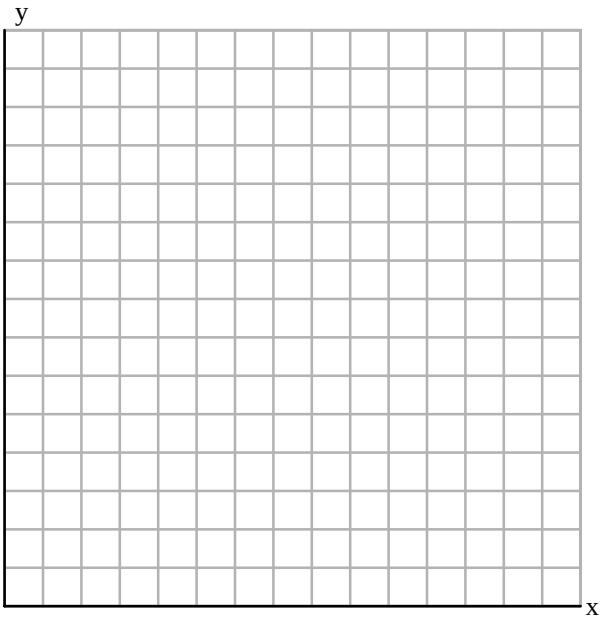
Step 3
Shine a 250 watt light bulb, located 20 cm away from the globe, directly on the equator. The light from the bulb represents the radiant energy from the sun.

CAUTION— This bulb gets very hot. Be very careful and do not touch the bulb. The lamp can be mounted on a stand.

Step 4
Record the temperature of each thermometer at 2-minute intervals for 1 hour. Graph your results. Use a different colored pencil to represent each thermometer. Put the time on the x-axis(across) and the temperature on the y-axis(up).

Time	Equator temp.	45° latitude	north or south pole

Time	Equator temp.	45° latitude	north or south pole



CONCLUSION

- Relate the flashlight shining on the paper to the concepts of how unequal absorption of radiation causes unequal heating of the earth's surface.
- Answer the questions posed in the beginning of the activity.

Night and Day

In this activity, students will conduct an experiment to help them understand what happens to the temperature of land and water during the day and at night

MATERIALS

- Four small bowls
- Two large bowls
- Potting soil (room temperature)
- Water (room temperature)
- Ice
- Two thermometers
- A Watch
- 250 watt bulb and lamp (if necessary)

QUESTIONS

How does the day and night effect the heating and cooling of Earth?
How do the rates of heating and cooling differ between land and water?

PROCEDURE

Step 1
Put water in 1 small bowl. Put potting soil in the second small bowl. Fill both bowls to the same depth. Place thermometers in both bowls. The thermometer bulbs should be placed 1 cm below the surface of both substances. Put both bowls in sunlight or under the 250 watt lamp. Record the temperatures of the water and soil after 3 min, 6 min, 9 min, and 12 min.

Step 2
Put the ice in the two large bowls. Put water in 1 small bowl. Put potting soil in the second small bowl. Fill both bowls to the same depth. Place thermometers in both

bowls. The thermometer bulbs should be placed 1 cm below the surface of both substances. Put each small bowl into the two large bowls with ice. Record the temperatures of the water and soil after 3 min, 6 min, 9 min, and 12 min.

Heating Temperatures

Time	Soil Temperature	Water Temperature
3 min		
6 min		
9 min		
12 min		

Cooling Temperatures

Time	Soil Temperature	Water Temperature
3 min		
6 min		
9 min		
12 min		

CONCLUSION

- Discuss which of the two, soil or water, heated and cooled faster.
- Discuss why there was a difference in the cooling and heating rates of the two.
- Answer the questions posed in the beginning of the activity.

EXTENDED ACTIVITIES

Heating your School

Allow students to go outside to collect data to determine how surfaces affect air temperature. Hand out a thermometer to each group of students if you need to economize. Have them prepare the thermometer by taping it to a meter stick so that the thermometer bulb is 10 cm above the bottom. Remind them to stand the stick straight up at each location and hold for two minutes or long enough for the liquid in the thermometer to stop moving. Afterwards, take a reading and record the temperature. Have them measure the temperature of the air over as many different surfaces as possible. Have them first make a prediction of the air temperatures. Then record the actual temperatures over surfaces such as the following: concrete, in the shade of a tree, in the shade of a building, grass, soil, etc.

Students can make a chart with the headings: location, surface, prediction of air temperature, and actual air temperature.

Students should record the temperatures of the air early in the morning, at midday, and in the evening for several days at the same time each day.

Create a discussion after each data collection period. Compare which surface air temperature was greatest, lowest, etc.

Optional: Students can make bar graphs of the air temperatures measured to show comparison at each location.

Weather Stations of the World

Compare the latitude of five weather stations and the present temperatures of those stations. Try to choose weather stations close to the same longitude line so that the stations are receiving approximately the same amount of sunlight.

Make a data table with the variables of “Latitude” and “Temperature”. Round off the latitude to the nearest degree and arrange the latitude of weather stations in ascending order. Record the temperature of the corresponding stations. Graph latitude and temperature.

World Weather Data

Have students use the Internet and other sources to find as much information as possible to support the following question: What factors cause air temperature to increase in some places more than in others? Have students use the Internet to find real-time data in which to compare their area to at least five other areas spread out across the U.S. or world. Examples of things to compare may include: Comparing the angle of sunlight by looking at a map, the temperature, number of daylight hours, type of ground cover, water sources, etc. Next have them chart their findings.

Have the students choose a planet to compare its atmosphere to that of Earth's.

Students can construct a chart to record the types of gases, mean temperature, and mean pressure.

ACTIVITY TWO
How is weather created?

This activity allows students to examine how air masses and clouds are formed.

Air Mass Formation

MATERIALS

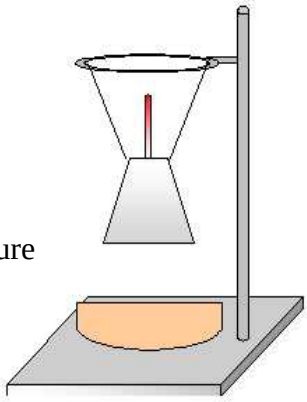
- Two bowls
- Hot water
- Ice
- Two thermometers
- Two ring stands
- Two plastic cups

QUESTIONS

- How are **air masses** formed?

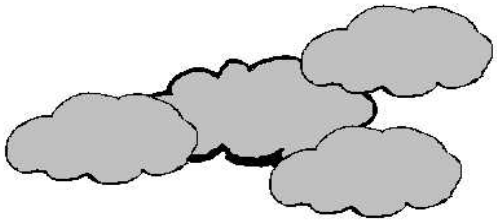
PROCEDURE

Step 1
Fill one bowl with ice. Fill the other bowl with hot water. Slip inverted cups over the lower ends of the thermometers and hang from the ring stand over the bowls. Measure the temperature over each bowl every minute for 5 min.



CONCLUSION

- Discuss the difference in temperatures of the air above each bowl.
- Compare the results of your experiment to real world effects on air masses at different locations.
- Answer the questions posed in the beginning of the activity.



Create Your Own Cloud

MATERIALS

- Large jar
- Plastic bag of ice that will fit over the jar opening
- Pitcher of warm water
- One sheet of black paper
- Flashlight
- Matches or chalk dust

QUESTION

- How are clouds formed?
- What is a cloud made of?

PROCEDURE

Step 1
Tape the black piece of paper onto the backside side of the jar. Pour the warm water into the jar until it is one third full. Light a match and hold it in the jar for a few seconds and then drop it in. You may have the students use chalk dust instead of matches by clapping an eraser over the opening of the jug. Quickly cover the mouth of the jar with the bag of ice. Shine the flashlight on the front of the jar.

CONCLUSION

- Answer the questions posed in the beginning of the activity.

EXTENDED ACTIVITIES

Discuss how the ocean affects our weather. Ocean currents such as the Gulf Stream are responsible for moving excess heat gained in the tropics to the poles, thus maintaining the Earth's thermal equilibrium. On average, the atmosphere and the ocean are equal partners in the amount of heat they transfer poleward. Sea-surface temperatures are used to determine how much heat is transferred between the atmosphere and the ocean. The temperature of the ocean also determines how much carbon dioxide can be absorbed from the atmosphere. Knowing how much is absorbed is important because carbon dioxide is one of the major greenhouse gases that maybe responsible for global warning. These models predicted that an increase in atmospheric carbon dioxide (CO_2) would cause a heightened greenhouse effect, which in turn would cause a rise in global temperatures.

ACTIVITY THREE
How do we measure the wind?

Wind and Wind Instruments

In this activity, students will investigate different types of winds and wind measurement. They will construct their own wind instruments.

TEACHER PREPARATION

Because different parts of Earth's surface get different amounts of sunlight, Earth has different areas of temperature. We call these different areas, **climate zones**. Earth has 5 different climate zones. They are:

Hot and humid
tropical rain forests and grasslands
Dry
deserts and grasslands, can be hot or cold
Short, mild winters and long summers
broadleaf forests and farmlands
Long, severe winters and short summers
pine forests and mountain areas
Cold and dry polar regions
tundra, glaciers

The climate of an area is how warm and wet that place is. It determines what kinds of plants and animals will live in that area. It also determines what type of activities people can do in that area. The activities that the people do can then have an effect on the climate! These effects can be good and/or bad. People should investigate what kind of effect their activities are going to have on their area before they do the activities.

Because of climates, different areas of temperature, Earth experiences wind. When

air moves from one place to another it makes a wind. Winds can be created in several ways. Air can be pushed. When you blow out a candle or turn on a fan you are pushing air. Changing temperatures also makes air move. Air that is warmed becomes lighter. The warm air rises up over the cold air. The rising warm air makes a wind. In the same way, air that is chilled becomes heavier. It sinks down. As it drops down it makes a wind. Also, air is moved from areas of high pressure to areas of low pressure. The air moving from high pressure to low pressure creates a wind by pushing the low pressure air out of the way so it can takes its place.

Global Winds

Global winds are the general trends in wind movement around the world. They are the result of the difference in heat across land masses and bodies of water. Global winds do not move directly from north to south or from south to north as they should. Instead the rotating movement of Earth deflects them. Since Earth rotates from west to east, the paths of the winds shift in relation to Earth's surface. In the Northern Hemisphere all winds curve to the right as they move. In the Southern Hemisphere they curve to the left.

Where global winds converge (come together) around the equator and in the mid latitudes, air rises, low pressure areas form and precipitation occurs. Where the global

winds diverge (move apart), air is sinking forming high pressure areas. Little precipitation occurs here.

Trade Winds

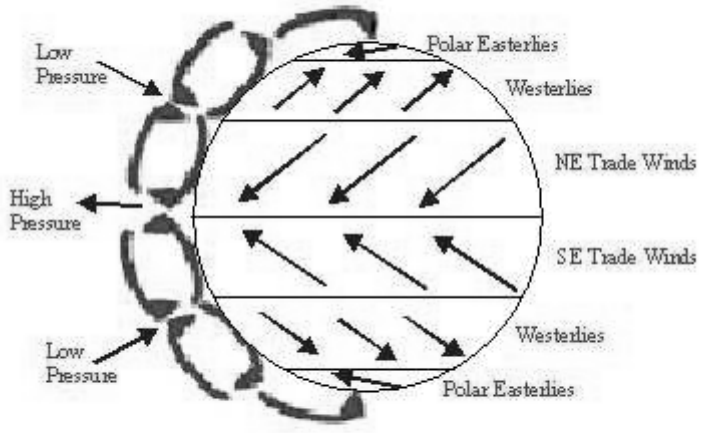
Warm air rising from the equator cools and begins to sink at about 30° north and south of the equator. Some of the sinking air travels back toward the equator. The rest of the sinking air continues to move toward the poles. This air moving back toward the equator forms a belt of warm steady winds called trade winds. This area usually has clear skies, few clouds, little rainfall and calm winds. Over the years, the trade winds have been harnessed for use as trade routes. In the Northern Hemisphere, they are the North East Trade winds and in the Southern Hemisphere they are the South East Trade winds. The reason for this change of direction around the equator is the spin of the earth and the resulting **Coriolis** effect.

Westerlies

Between the latitudes of 30° and 60° north and 30° and 60° south blow the Westerlies. The cool sinking air from the equator that continues to move toward the poles is affected by the Coriolis effect. In both hemispheres these winds appear to travel west to east. Since winds are named according to the direction from which they blow these winds are called the prevailing westerlies. Although these are not the Trade winds they have been used for intercontinental trade for a long time.

Polar Easterlies

The Westerlies start rising and cooling between 50° and 60° latitude as they approach the poles. They meet extremely cold air flowing toward the equator from the poles. This band of cold air is deflected west so it appears to travel from east to west. These winds are called the polar Easterlies. They are weak but cold winds. Each polar cap has its own set of Easterlies. In many respects, they are replicas of the Northeast and Southeast Trade winds.



Doldrums

A belt of air around the equator receives much of the sun's radiant energy. The warm, rising air produces a low pressure area that extends many miles north and south of the equator. Normally cooler, high-pressure air would flow into such an area creating winds. But the cooler air is warmed so rapidly that the winds, which form cannot move into the low-pressure area. So any winds that form are weak.

Jet Streams

Jet streams are bands of very strong winds, which occur at limited altitudes (generally in the 30-40000 feet area). They can be over 150 miles wide and 1000 miles long and can travel at over 250 mph.

Like most winds they occur where there is a contrast between hot and cold, and in the jet stream's case this between tropical and polar air.

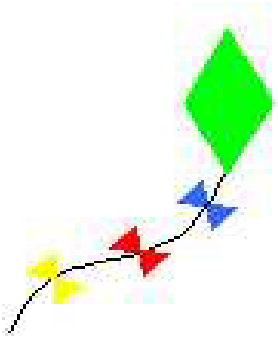
TEACHER PREPARATION

The ULDB will be flying in the Southern Hemisphere and could be influenced by the Trade winds, Westerlies and Easterlies. After the students have completed these activities, have them discuss the possible path of the ULDB as determined by the winds. The students can also investigate further the speed of the winds, the influence of the wind at the altitude at which the ULDB will be flying, and the length of time it will take the balloon to travel around the world.

Go Fly a Kite

MATERIALS

- Kite



QUESTIONS

- How does the wind move today?

PROCEDURE

Step 1
Watch as your teacher flies a kite for the class. Notice the movement of the kite, the direction the kite moves and how fast the kite travels.

CONCLUSION

- Discuss how the movement of air influences kites.
- Using the Wind Force Scale describe the wind today.

Wind Force Scale

In 1806, Sir Francis Beaufort developed a rating system for accurate recording of wind speed. This system was developed for sailors, but has since been modified by the National Weather Service (NWS) for use on land.

Wind Speed (MPH)	Indicators	Terms Used in NWS Forecasts
0 – 1	Calm; smoke rises vertically.	Calm
1 – 3	Shown by direction of wind smoke drift, but not by wind vanes	Light
4 – 7	Wind felt on face, leaves rustle; ordinary vanes moved by wind.	Light
8 – 12	Leaves and small twigs in constant motion; wind extends light flag.	Gentle
13 – 18	Raises dust and loose paper; small branches are moved.	Moderate

19 – 24	Small trees in leaf begin to sway; crested wavelets form on inland waters.	Fresh
25 – 31	Large branches in motion; whistling heard in telephone wires; umbrellas used with difficulty.	Strong
32 – 38	Whole trees in motion; inconvenience felt walking against the wind.	Strong
39 – 46	Breaks twigs off trees; generally impedes progress.	Gale
47 – 54	Slight structural damage.	Gale
55 – 63	Seldom experienced inland; trees uprooted; considerable structural damage occurs.	Whole gale
64 – 72	Very rarely experienced inland; accompanied by widespread damage.	Whole gale
73 or more	Very rarely experienced; accompanied by widespread damage.	Hurricane

Air Currents

MATERIALS

- One jar
- One small weight
- Two colored ice cubes
- One twist tie or rubberband
- Water

QUESTIONS

- What causes the wind?

PROCEDURE

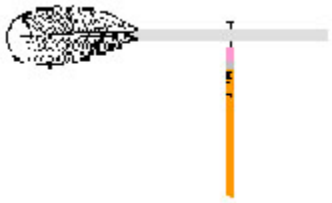
Step 1
Fill the jar 3/4 full with hot tap water. Gently put one ice cube in the jar. Watch what happens to the cold water as the ice cube melts.

Step 2
Empty the jar and refill it 3/4 full with hot tap water. Tie the ice cube and the weight together with the twist tie or rubber band. Discuss with your group or class whether or not you think this ice cube will float or sink when you put in the jar? Gently put the ice cube into the jar.

CONCLUSION

- Discuss what happened to the colored water as the ice melted in each step.
- Discuss the similarities between hot and cold water and hot and cold air.
- Relate the experiment results to the movement of the hot and cold air in the atmosphere.
- Answer the questions posed in the beginning of the activity.

Making a Wind Vane



MATERIALS

- Feather
- Straight pin
- Drinking str
- New lead pencil with firm eraser

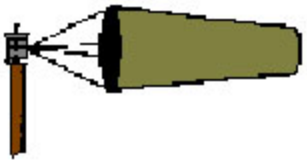
QUESTIONS

- How can we approximate the wind direction?

PROCEDURE

Step 1
Insert a 6"- 8" feather in one end of the straw, gluing lightly, if desired. Find the balance point by holding the straw on an extended finger so it will not tip; insert pin at this point and stick pin into eraser. Vane will move with the wind, always pointing in the direction from which the wind is blowing.

Making a Windsock



MATERIALS

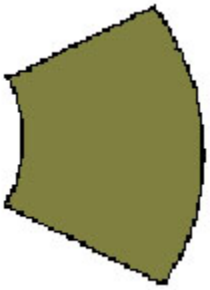
- Heavy cloth, about 90cm x 60cm
- Four pieces (about 25cm each) of heavy wire
- Wire coat hanger
- Stick (about one meter long)
- Large nail
- Wooden spool
- Stapler or duct tape

QUESTIONS

- How can we determine wind direction?

PROCEDURE

Step 1
Form the hanger into a loop about 23 cm in diameter. Attach the 4 wires to this circular loop at 4 equidistant points on its circumference.



Step 2
Cut cloth into a sleeve (see diagram). Staple or tape the sides together, making a cone, and attach the larger end of the cone to loop.

Step 3
Bind exposed ends of wires to the spool. Place the nail through the spool so that the spool may pivot freely on the nail, and hammer the nail into the end of the long stick.

Step 4
Place the stick outdoors; nail it to a tall post or to a rooftop away from obstructions, so that the sock may swing freely with the wind.

The large end of the sock should catch the wind, so that the small end will point away from the direction from which the wind is blowing, or will droop if there is not enough wind to keep it extended.

CONCLUSION

- Observe the position of the sock at different times for changes in direction and force of the wind.
- Answer the questions posed in the beginning of the activity.

Windsocks are used chiefly at airports to indicate wind direction for takeoffs and landings. They help the pilots select the proper runway, so that they can take off and land into the wind. Next time you are at the airport look for the orange wind sock.

Making a Wind Anemometer

MATERIALS

- Four small paper cups
- Tape
- Scissors
- Four plastic drinking straws
- Straight pin
- Pencil with a new eraser
- Stapler

QUESTIONS

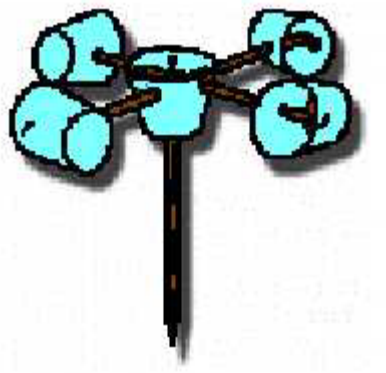
- How can we measure wind speed?

ACTIVITY

Step 1
Arrange four plastic drinking straws to form a cross and tape them together at the center. Staple the top side of one drinking cup to the end of each straw or push the straws through the cups, so the open ends of the cups all face the same direction.

Step 2
Push a straight pin through the center of the straws into an eraser on the end of a pencil. This provides the axle. Blow on the anemometer or turn an electric fan on low to make sure that it spins easily.

Step 3
The instrument that is used to measure wind speed is called an anemometer, an indicator that will spin in the wind. The anemometer rotates at the same speed as the wind. It gives a direct measure of the speed of the wind. Hold the anemometer in a place that has full access to the wind from all directions. Unlike the weather vane, it need not be pointed into the wind to spin.



EXTENDED ACTIVITY

An anemometer has four cups, which catch the wind and cause the anemometer to spin. The inward curve of the cups receives most of the force of the wind. That's what makes the cups move. The more spins per minute, the greater the wind velocity. Using the average student-made anemometer, 10 turns per minute means the wind speed is about one mile per hour. Mount or hold the anemometer in a place that has full access to the wind from all directions.

Have students use their anemometers to measure the outside wind speed. Before you go outside mark one of the cups ; this will be the one they use for counting when the anemometer spins. Each group should appoint a time keeper who will be responsible for timing one minute for each trial. Each group should appoint an official "counter" for the day. The others may count on their own, but the counter's readings will be the ones recorded.

Using the Beaufort Wind Scale , wind velocity is measured on a scale of 0-12, based on visual clues. Depending on the ability of students, it is probably sufficient that they recognize calm air, and gentle, moderate, and strong breezes.

Each group should appoint a holder who will hold the anemometer while the spins are counted; the holder should make sure that the anemometer is held so that the wind is unobstructed.

When you are outside, ask the students to describe the wind condition in words. Have the students set up their anemometers. They should make predictions as to how many times the anemometer will spin in one minute. When the time keeper says “Go” the counter in each group will count how many times the marked cup passes them in one minute and write it down.

Making a Weather Vane

MATERIALS

- Thin wood strips (white pine is good): one 20" x 4"
  two 12" x l”
  four 8" x 3"
- Long, slender nail
- Small nails
- Wooden or glass bead
- Post about 10' high (or exposed corner of building)

QUESTIONS

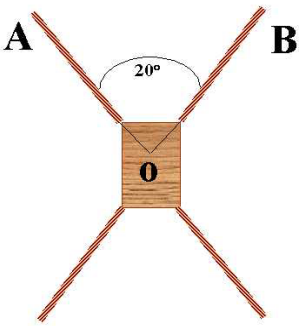
- How can we measure wind direction?

PROCEDURE

Step 1
Cut arrow and shaft from the 20" wood strip. Cut tailpieces from the 8" wood strips.

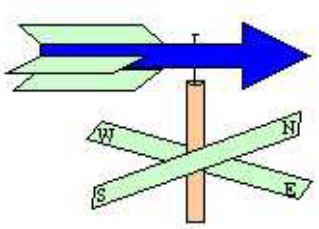
Step 1
Cut arrow and shaft from the 20" wood strip. Cut tailpieces from the 8" wood strips.

Step 2
Nail or glue the tailpieces to shaft of arrow on each sid Use a protractor to measure angle AoB (see illustration).



Step 3
Find the balance poi of the arrow by resting the shaft on extended finger until arrowhead and tailpieces balance level; drill a hole at this point. Insert long nail in the hole. Place bead on nail to act as bearing. Mount on post, preferably away from building.

Step 4
With compass, determine north. Using the 12" strips, one marked N and S, and the other E and W, as pointers, nail the pointers on the post to show direction from which the wind is blowing. Observe the cha

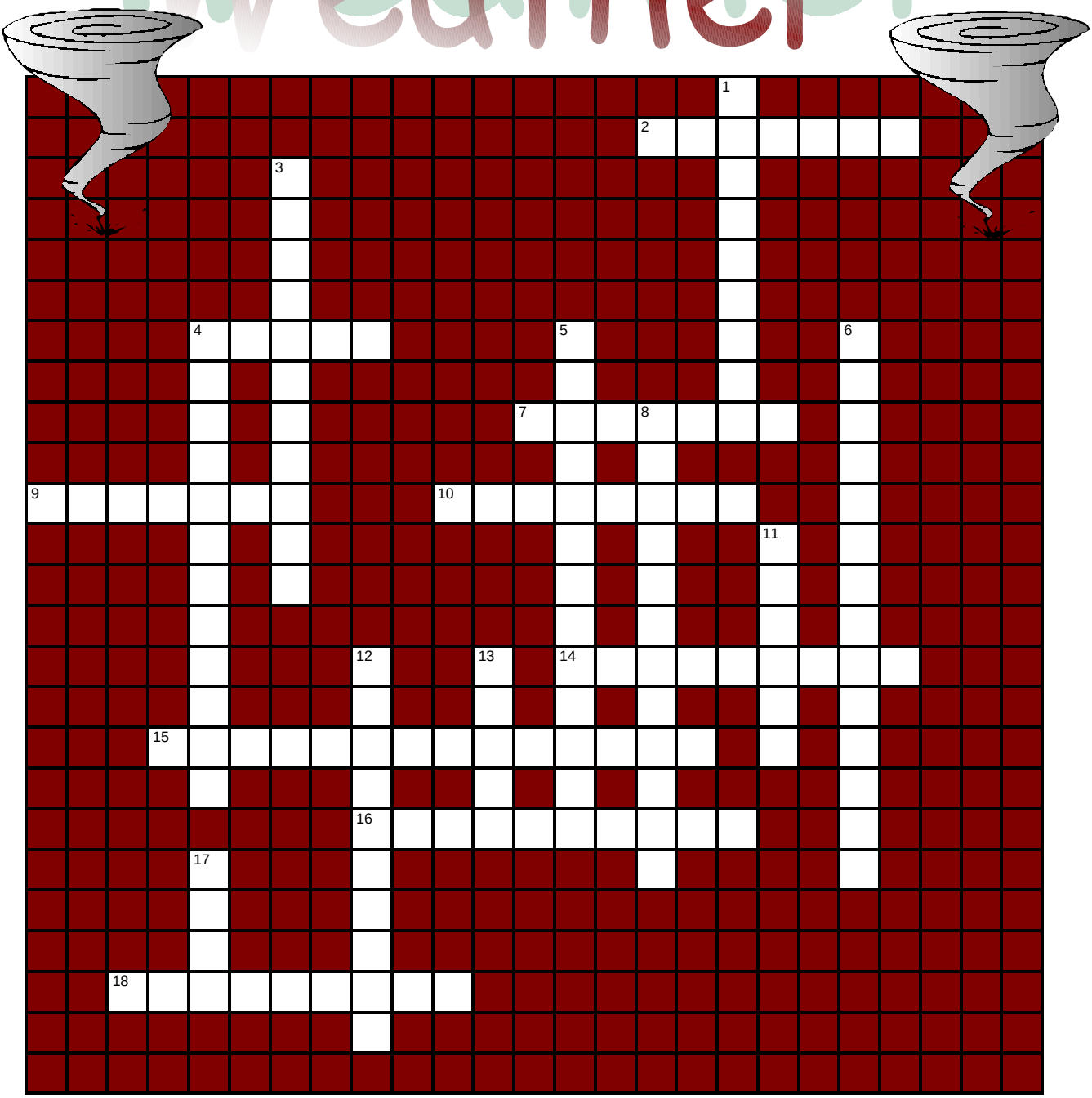


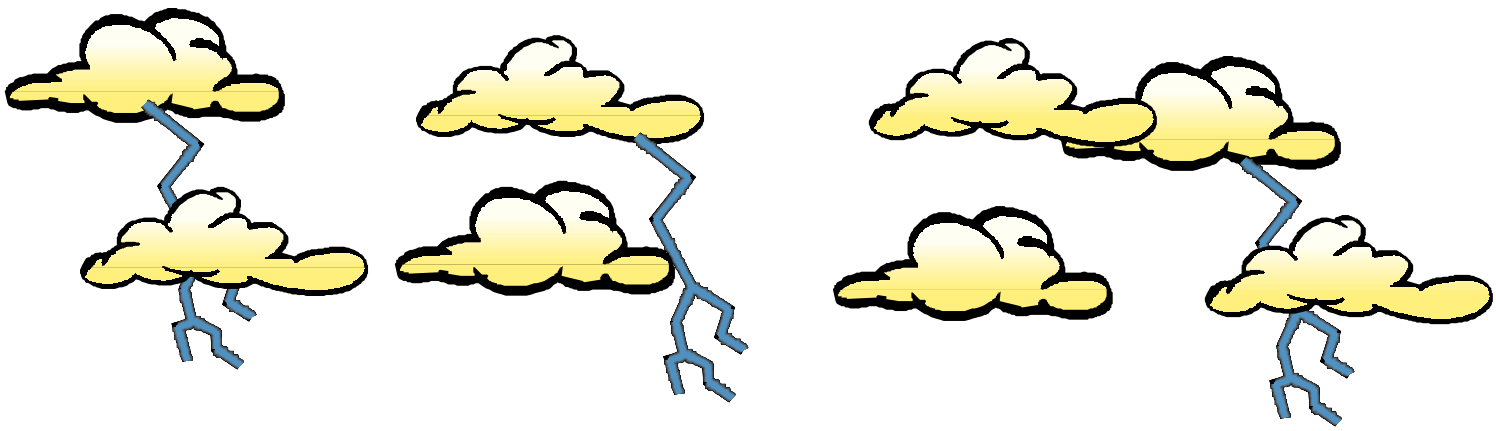
EXTENDED ACTIVITY

The Daily Weather

Have the students construct a daily weather chart. Have them decide individually or in groups what characteristics should be measured, what units each is measured in, and how to best set up the chart. Share ideas with the whole class. After construction of the chart, record daily weather conditions. These results can then be used to make basic forecasts, to compare with forecasts made by newspapers and TV stations, to construct graphs, etc.

Weather





Weather Clues

Across

2. divides Earth into the northern and southern hemispheres

4. a floating group of water vapor

7. state of the atmosphere at any given time or place

9. a violent and destructive windstorm

10. _____ lines “cut” Earth horizontally

14. a body of air with approximately the same temperature and humidity

15. the weather man on the television is a _____

16. greenhouse gases trap _____ that raises the temperature of Earth

18. type of harmful energy released by the sun

Down

1. tropical storm

3. the study of predicting weather

4. areas that have the same weather patterns

5. snow, rain, hail are forms of _____

6. the _____ is caused by Earth’s rotation

8. A storm with loud noises and flashes of light

11. a particular time of the year when the weather is similar

12. _____ runs from the north pole to the south pole through the center of Earth

13. boundary between two air masses

17. a kite will not fly with out the _____